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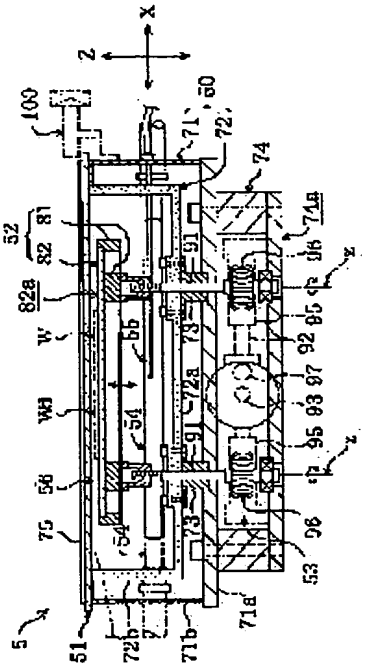
(71)Applicant : NIPPON DEJITETSUKU:KK
(72)Inventor : KATO SATOTOSHI
NAGANO SHIGE

(54) HEAT LOAD DEVICE OF OPTICAL SHAPE MEASURING WORK AND OPTICAL SHAPE MEASURING EQUIPMENT EQUIPPED WITH HEAT LOAD DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To give a heat load surely and easily without exerting a bad influence on measurement and a work itself relative to the optical shape measuring work.
SOLUTION: An optical shape measuring system is held vertically movably by a Z-stage from above, relative to a heat load device 5 set on an XY-stage. As the heat load device 5, the upper surface of a hermetic container 50 having a double structure is shielded by a closing window 51 made of heat-resistant glass, and a work support stand 52 is arranged vertically movably by a lifting means 53 in an inside container 72 formed by heat insulating material. A space in the inside container 72 is roughly divided vertically by a support plate 82 made of heat-resistant glass, and a ceramic heater 54 and a thermocouple 55 for detecting an atmospheric temperature are arranged in the lower side space, and a work W is placed on a support surface 82a and arranged in the upper side space. A work temperature is detected by a thermocouple 56 mounted on a dummy work Wd. After controlling the atmospheric temperature at a target temperature, the work temperature is controlled to become the target temperature.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] It is thermal load equipment of the work piece for optical configuration measurement which gives a thermal load to the work piece with which the exposure light from optical configuration system of measurement is received, and a configuration is measured based on the reflected light. A well-closed container, It has the work-piece susceptor which is arranged in this well-closed container and supports a work piece, and the heat source to which the temperature up of the work piece supported by this work-piece susceptor is carried out. To the above-mentioned well-closed container The transparence aperture formed with the ingredient which is a transparent material which may pass the exposure light from the optical system to the optical system of the above-mentioned optical configuration system of measurement in the location which carries out phase opposite, and has thermal resistance is prepared. The above-mentioned work-piece susceptor is arranged so that the back face of owner Perilla frutescens (L.) Britton var. crispa (Thunb.) Decne. may carry out phase opposite and may carry out the right pair of the back face made into the flat side to the above-mentioned transparence aperture to the exposure light from the above-mentioned optical system. The above-mentioned heat source Thermal load equipment of the work piece for optical configuration measurement characterized by being constituted so that it may be arranged [as opposed to / both / the above-mentioned work piece and work-piece susceptor] in the state of non-contact and the ambient atmosphere in the above-mentioned well-closed container may be heated.
[Claim 2] Thermal load equipment of the work piece for optical configuration measurement characterized by having the air curtain means forming which forms an air curtain between both transparence aperture and optical system in claim 1 so that the space between the both may be intercepted.
[Claim 3] It is thermal load equipment of the work piece for optical configuration measurement characterized by forming work-piece susceptor in tabular, being arranged in claim 1 so that the abbreviation partition of the space in a well-closed container may be carried out up and down, and arranging the above-mentioned work-piece susceptor so that heating according [a heat source] to the heat source while being arranged so that the back face may attend top space may be performed to the bottom space of the above-mentioned work-piece susceptor.
[Claim 4] It is thermal load equipment of the work piece for optical configuration measurement which a back face is a heat-resistant ingredient in claim 1, and is characterized by being formed with the ingredient which has the low specific heat other than a metal.
[Claim 5] It is thermal load equipment of the work piece for optical configuration measurement characterized by being the heating element with which the heat source was arranged in the well-closed container in claim 1.
[Claim 6] Thermal load equipment of the work piece for optical configuration measurement characterized by having an attitude means to support work-piece susceptor possible [an attitude] in accordance with the exposure optical axis from optical configuration system of measurement, in claim 1.
[Claim 7] An ambient temperature detection means to detect the ambient temperature in a well-closed container in claim 1, A work-piece temperature detection means to detect the temperature of the work piece supported by work-piece susceptor, It has a temperature control means to control heating actuation of the source of heating so that work-piece temperature turns into target temperature in response to the detecting signal from the above-mentioned ambient temperature detection means and a work-piece temperature detection means. The above-mentioned temperature control means is in the 1st control section which carries out actuation control of the above-mentioned source of heating so that the ambient temperature in a well-closed container may turn into the above-mentioned target temperature in response to the detecting signal from the above-mentioned ambient temperature detection means, and the condition to which the above-

mentioned ambient temperature reached target temperature. Thermal load equipment of the work piece for optical configuration measurement characterized by having the 2nd control section which carries out actuation control of the above-mentioned source of heating so that work-piece temperature may turn into the above-mentioned target temperature in response to the detecting signal from the above-mentioned work-piece temperature detection means.

[Claim 8] An optical configuration measurement means to measure the shape of surface type of the above-mentioned work piece by receiving the reflected light to the exposure light from optical system, and measuring the amount of relative displacements with a work piece, The Z stage which holds this optical configuration measurement means movable to Z shaft orientations of the rectangular cross 3 shafts which consist of XYZ, The thermal load equipment which supports a work piece and gives a thermal load to the work piece so that a right pair may be carried out to the exposure light from the above-mentioned optical configuration system of measurement, It has the X-Y stage which holds this thermal load equipment movable to both the above-mentioned X-axis and a Y-axis. The above-mentioned thermal load equipment It has a well-closed container, the work-piece susceptor which is arranged in this well-closed container and supports a work piece, and the heat source to which the temperature up of the work piece supported by this work-piece susceptor is carried out. To the above-mentioned well-closed container The transparence aperture formed with the ingredient which is a transparent material which may pass the exposure light from the optical system to the optical system of the above-mentioned optical configuration system of measurement in the location which carries out phase opposite, and has thermal resistance is prepared. The above-mentioned work-piece susceptor is arranged so that the back face of owner Perilla frutescens (L.) Britton var. crispa (Thunb.) Decne. may carry out phase opposite and may carry out the right pair of the back face made into the flat side to the above-mentioned transparence aperture to the exposure light from the above-mentioned optical system. The above-mentioned heat source The optical configuration measurement machine equipped with the thermal load equipment characterized by being constituted so that it may be arranged [as opposed to / both / the above-mentioned work piece and work-piece susceptor] in the state of non-contact and the ambient atmosphere in the above-mentioned well-closed container may be heated.

[Claim 9] The optical configuration measurement machine equipped with the thermal load equipment characterized by having the air curtain means forming which forms an air curtain between both transparence aperture and optical system in claim 8 so that the space between the both may be intercepted.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention carries out the temperature up of the work piece to a certain elevated-temperature condition, and relates to the thermal load equipment of the work piece for optical configuration measurement used in order for an optical configuration measurement machine to perform surface type-like measurement of the work piece under this elevated-temperature condition. It is used more in detail suitable for the optical configuration measurement under the high temperature loaded condition by using a semiconductor package, a multilayer printed board, or precision metal mold, such as CSP (Chip Size Package), BGA (Ball Grid Array), and MCM (Multi Chip Module), etc. as a measuring object work piece.
[0002]
[Description of the Prior Art] For the above-mentioned semiconductor package etc. from before as an optical configuration measurement technique which measures the shape of minute surface toothing etc. with high degree of accuracy (for example, order below mum) The technique (for example, refer to JP,9-264733,A) which forms the interference fringe corresponding to surface irregularity in the front face of a work piece by the interference of light wave, and measures the shape of toothing on the front face of a work piece (display flatness) based on this interference fringe, The technique which detects a focus location using technique, such as the knife-edge method, based on the reflected light at the time of irradiating a laser beam etc. through optical system to a work piece, and measures the shape of toothing on the front face of a work piece based on change of the focus location is known well (for example, refer to JP,11-39673,A). And configuration measurement by the optical configuration measurement technique like the above is usually performed under ordinary temperature (room temperature) by using the final product as a measuring object work piece for inspection of a final product.
[0003]
[Problem(s) to be Solved by the Invention] By the way, there is a thing used by measuring object work pieces, such as a semiconductor package, under a high temperature environment inside or a thing which receives the processing under a high temperature environment in the phase of a manufacture process until it results in a final product. About such a work piece, there is a demand of wanting to grasp and evaluate the shape of variability in the same thermal load environment (for example, about 300 degrees C) as a busy condition or a processing state beforehand.
[0004] however, the form status change of the work piece under the thermal load environment like the above -- voltinism -- the following inconvenient generating can be considered for the above-mentioned conventional optical configuration measurement technique to perform grasp and evaluation of a **.
[0005] That is, although contacting the work piece itself to a panel heater etc. soon, and heating it directly as a means to set a work piece by the above-mentioned thermal load environment is also considered, there is a possibility that the work piece may spoil the function of the work piece itself as it is the semiconductor package which used the resin substrate also especially among semiconductor packages, and, in such a case, a work piece cannot be heated directly.
[0006] Since the heat damage (heat damage) of optical system will be caused, carrying out the temperature up of the whole ambient atmosphere including optical configuration system of measurement to an elevated temperature on the other hand needs to give a thermal load to a work piece, where the thermal effect to optical system is prevented as much as possible.
[0007] When the method which detects an above focus location especially performs configuration measurement, it is necessary to set up almost equally to a focal distance spacing of optical system (for example, objective lens) and a work piece, and this spacing becomes very short (for example, 10 - 10mm of

numbers). For this reason, it becomes difficult to give a thermal load to a work piece, where the heat damage to optical system is prevented.
[0008] Moreover, the effect of the deformation will also attain to the work piece then supported by the susceptor so that the susceptor which supports a work piece may produce deformation of curvature, deflection, etc. in response to a thermal load, and the shape of deformans of the work piece itself cannot measure in character. For this reason, even if it receives a thermal load as susceptor, it is necessary to make it what can maintain a flat-surface configuration certainly.
[0009] Furthermore, when giving a thermal load, it is necessary to carry out the temperature up of the temperature of the work piece itself to target temperature correctly but, and when the direct temperature detection by what [what the work piece of the measuring object cannot detect directly from temperature itself], i.e., contact, is impossible, the thermal control for giving a thermal load will become difficult.
[0010] This invention is made in view of such a situation, and the place made into the purpose is to offer the optical configuration measurement machine equipped with the thermal load equipment which can give a thermal load certainly and easily, and such thermal load equipment, without having a bad influence on the work piece for optical configuration measurement at measurement and the work piece itself of opposite Perilla frutescens (L.) Britton var. crispa (Thunb.) Decne.
[0011]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, paying attention to what is necessary being just to make a shelter intervene in between so that the thermal load to a work piece may be received from the ambient atmosphere which the work piece touches and direct propagation may not receive heat from a heat source through the ambient atmosphere, this invention adds a device variously and is completed.
[0012] The 1st invention relates to the thermal load equipment of the work piece for optical configuration measurement, and, specifically, is equipped with the following specific matters for the thermal load equipment of the work piece for optical configuration measurement which gives a thermal load to the work piece with which the exposure light from optical configuration system of measurement is received, and a configuration is measured based on the reflected light. That is, it has a well-closed container, the work-piece susceptor which is arranged in this well-closed container and supports a work piece, and the heat source to which the temperature up of the work piece supported by this work-piece susceptor is carried out. And the transparence aperture formed with the ingredient which is a transparent material which may pass the exposure light from the optical system to the optical system of the above-mentioned optical configuration system of measurement in the location which carries out phase opposite, and has thermal resistance prepares to the above-mentioned well-closed container, and it arranges so that the back face of owner Perilla frutescens (L.) Britton var. crispa (Thunb.) Decne. may carry out phase opposite and may carry out the right pair of the back face made into the flat side to the exposure light from the above-mentioned optical system as the above-mentioned work-piece susceptor to the above-mentioned transparence aperture. In addition, it constitutes so that it may be arranged [as opposed to / both / the above-mentioned work piece and work-piece susceptor] in the state of non-contact as the above-mentioned heat source and the ambient atmosphere in the above-mentioned well-closed container may be heated.
[0013] What is necessary is here, just to adopt heat-resisting glass as the ingredient and general target which penetrate that there is no loss of exposure light at least, and have thermal resistance like the above as a formation ingredient of a "transparence aperture." Although absorption or reflection of the radiant heat in the above-mentioned well-closed container can expect also with this heat-resisting glass, in order to attain certain-ization of the heat damage prevention to optical system further, the heat reflective glass which attached the metal thin film which reflects the ingredient which may intercept or reflect positively the radiant heat in the above-mentioned well-closed container, for example, the heat absorbing glass which added the metallic element of a minute amount, and an infrared region may be used. What is necessary is just made to perform setup or selection so that it may become the transmission loss of extent which does not influence the accuracy of measurement in these cases in relation with the wavelength of the exposure light from optical configuration system of measurement. Moreover, transparent heat resistant resin may be chosen as the above-mentioned formation ingredient with extent of a thermal load.
[0014] In addition, you may make it establish the air curtain means forming which forms an air curtain between both above-mentioned transparence aperture and optical system so that the space between the both may be intercepted from a viewpoint which attains much more certain-ization of the heat damage prevention to the above-mentioned optical system.
[0015] While making it the back face which supports a work piece by arranging so that it may form in

tabular and the abbreviation partition of the space in a well-closed container may be carried out up and down as "work-piece susceptor" attend top space, heating by the heat source should just be made to be performed to the bottom space of the above-mentioned work-piece susceptor. By this, moreover, the thermal load to a work piece will be further given to homogeneity much more indirectly by the convection current of the ambient atmosphere in a well-closed container. Moreover, as an ingredient which constitutes the "back face" by which the work piece of the above-mentioned work-piece susceptor is supported, it is a heat-resistant ingredient and it is desirable to make it form with the ingredient which has the low specific heat other than a metal. That is, it is desirable that it is the ingredient of low-fever capacity so that it can cool quickly by the case where have the thermal resistance of extent which can maintain the condition of having supported the work piece W to homotopic, without advancing curvature and deflection at least even if it receives the thermal load of high temperature (for example, 300 degrees C), and a thermal load and cooling are performed in the cycle of a repeat. For example, the resin which has the heat-resisting glass plate of predetermined thickness or predetermined thermal resistance is mentioned.

[0016] Moreover, in order to set spacing of the optical system of optical configuration system of measurement, and a work piece as a predetermined distance according to the focal distance of the optical system, you may make it establish an attitude means to make the above-mentioned work-piece susceptor move to optical system within a well-closed container. Thereby, even if it is a case so that the thickness of a work piece may change for every class, it becomes possible to position the front face of the work piece in a proper location easily according to the above-mentioned focal distance.

[0017] What is necessary is just to adopt the hot blast circulation means which consists of a blower, circulation piping, etc., such as a heater and a blower, so that hot blast may be supplied and circulated in a well-closed container that what is necessary is just to adopt the heating element to which it carries out the temperature up of the ambient atmosphere in a well-closed container with the radiant heat from external surface as a "heat source" in arranging in a well-closed container, in arranging out of a well-closed container.

[0018] And it may be made to perform temperature control like a less or equal from a viewpoint which attains exact-ization of the amount of thermal loads to a work piece, and aims at implementation of highly precise thermal load conditions. That is, an ambient temperature detection means to detect the ambient temperature in a well-closed container, a work-piece temperature detection means to detect the temperature of the work piece supported by work-piece susceptor, and a temperature control means to control heating actuation of the source of heating so that work-piece temperature turns into target temperature in response to the detecting signal from the above-mentioned ambient temperature detection means and a work-piece temperature detection means are established first. And it shall have the 1st control section which carries out the actuation control of the above-mentioned source of heating so that the ambient temperature in a well-closed container may turn into the above-mentioned target temperature as the above-mentioned temperature-control means in response to the detecting signal from the above-mentioned ambient-temperature detection means, and the 2nd control section carry out actuation control in the above-mentioned source of heating so that work-piece temperature may become to the above-mentioned target temperature in response to the detecting signal from the above-mentioned work-piece temperature detection means, after the above-mentioned ambient temperature has reached target temperature.

[0019] Under the present circumstances, when the work piece itself is what cannot carry out direct detection of the detection of work-piece temperature from that work piece, work-piece temperature can be exactly detected by adopting one means of the degrees as a work-piece temperature detection means. That is, susceptor is made to support with the work piece of the measuring object as the 1st means by using the same work piece as the work piece of the measuring object as a dummy work piece, and a thermal load is made to act in both the same environments. By carrying out direct detection of the work-piece temperature of a dummy work piece then, it considers as the work-piece temperature of the work piece of the measuring object. It is detecting the skin temperature of a work piece through a transparence aperture, using a radiation thermometer as the 2nd means. In that case, the correction value over a decreased part of the radiant heat by a transparence aperture existing in between is beforehand calculated by trial, and work-piece temperature is indirectly detected by carrying out amendment by the above-mentioned correction value to the detection temperature by the radiation thermometer at the time of actual measurement. Even if it is the case where these cannot perform temperature detection directly from the work piece of the measuring object itself, it becomes possible to detect the work-piece temperature exactly.

[0020] Moreover, an optical configuration measurement means to measure the shape of surface type of the above-mentioned work piece by the 2nd invention relating to the optical configuration measurement

machine equipped with above thermal load equipment, receiving the reflected light to the exposure light from optical system, and measuring the amount of relative displacements with a work piece, The Z stage which holds this optical configuration measurement means movable to Z shaft orientations of the rectangular cross 3 shafts which consist of XYZ, It shall have the thermal load equipment which supports a work piece and gives a thermal load to that work piece so that a right pair may be carried out to the exposure light from the above-mentioned optical configuration system of measurement, and the X-Y stage which holds this thermal load equipment movable to both the above-mentioned X-axis and a Y-axis. And it shall have the work-piece susceptor which is arranged in a well-closed container and this well-closed container, and supports a work piece as the above-mentioned thermal load equipment, and the heat source to which the temperature up of the work piece supported by this work-piece susceptor is carried out, and shall have the following specific matters as each component. The transparence aperture formed with the ingredient which is a transparent material which may pass the exposure light from the optical system to the optical system of the above-mentioned optical configuration system of measurement in the location which carries out phase opposite, and has thermal resistance is prepared to the above-mentioned well-closed container. Namely, as the above-mentioned work-piece susceptor It considers as the configuration which arranges so that the back face of owner Perilla frutescens (L.) Britton var. crispa (Thunb.) Decne. may carry out phase opposite and may carry out the right pair of the back face made into the flat side to the above-mentioned transparence aperture to the exposure light from the above-mentioned optical system, is arranged [as opposed to / both / the above-mentioned work piece and work-piece susceptor] in the state of non-contact as the above-mentioned heat source, and heats the ambient atmosphere in the above-mentioned well-closed container.

[0021] You may make it have the air curtain means forming which forms an air curtain between both above-mentioned transparence aperture and optical system like the 1st invention so that the space between those both may be intercepted also in this 2nd invention from the viewpoint which attains certain-ization of the heat damage prevention to the above-mentioned optical system.

[0022] In the above-mentioned 1st or the 2nd above-mentioned invention, in thermal load equipment, the ambient atmosphere in a well-closed container will be heated according to a heat source, the heated ambient atmosphere will be contacted, and the whole work piece will receive a thermal load. For this reason, it becomes possible for there to be also no generating of the functional damage by operation of a local thermal load to a work piece, and to give a thermal load to homogeneity to the whole work piece. And the exposure light from the optical system of optical configuration system of measurement will be irradiated through a transparence aperture to the work piece which received the thermal load in this way, and configuration measurement of a work piece will be performed. In that case, the ambient atmosphere and work piece in which the temperature up was carried out by the heat source are sealed in a well-closed container, the transparence aperture which carries out phase opposite will also be formed in optical system of the transparent material which has thermal resistance, and they can expect reflection or absorption of the radiant heat from the interior of a well-closed container, and can also prevent generating of the heat damage to the above-mentioned optical configuration system of measurement or its optical system.

[0023] Especially, in the 2nd invention, thermal load equipment is held on an X-Y stage, and becomes possible [the thing of the request of a work piece on a X-Y flat surface to do for location relative displacement] to optical configuration system of measurement. Since the amount of displacement of Z shaft orientations in each location of such a work piece is measured by the optical configuration system of measurement moved to Z shaft orientations, it becomes possible to acquire easily and certainly the shape of configuration variability from [of the work piece under a thermal load environment] three dimensions.

[0024]

[Effect of the Invention] As mentioned above, as explained, according to the thermal load equipment of the work piece for optical configuration measurement concerning the 1st invention, Lycium chinense comes grow in the bottom of the thermal load environment of a request of the work piece, without being able to give and carry out the thing of the thermal load to homogeneity and an indirect target to the whole work piece, and causing functional damage of the work piece itself. For this reason, inspection or evaluation of the shape of configuration variability in that busy condition or processing state can be beforehand performed exactly about the work piece used under a high temperature service, the work piece which receives the processing under high temperature at the process to a final product.

[0025] Moreover, according to the optical configuration measurement machine equipped with the thermal load equipment concerning the 2nd invention, the shape of configuration variability from [the] three dimensions can be measured and grasped easily and certainly about the work piece which a thermal load is given by the thermal load equipment concerning the 1st above-mentioned invention, and is in a thermal load

environment, inhibiting generating of the heat damage to optical configuration system of measurement.
[0026]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to a detail based on a drawing.
[0027] Drawing 1 shows the optical configuration measurement machine incorporating the thermal load equipment concerning the operation gestalt of this invention, and this thermal load equipment. The X-Y stage by which one was installed in the frame among this drawing, and 2 was installed in the frame 1, the Z stage by which 3 was similarly held by the above-mentioned frame 1, the optical configuration system of measurement by which 4 was held by this Z stage 3, the thermal load equipment with which 5 was held by above-mentioned X-Y stage 2, and 6 are the control systems equipped with the controller 61 for gauge control of the above-mentioned optical configuration system of measurement 4, and the controller 62 for temperature control of thermal load equipment 5. Hereafter, each component is explained to a detail.
[0028] The above-mentioned frame 1 consists of perpendicular base members 12 fixed so that it might intersect perpendicularly from a surface plate 10 and this surface plate 10 to the top face of a surface plate 10 by the arms 11 and 11 of the pair extended by the upper part, and the arms 11 and 11 of these pairs. The above-mentioned surface plate 10 is installed on the installation side S through the oscillating absorption mountings 13 and 13 and -- which were constituted by the laminating rubber member etc. In addition, 14 in drawing 1 is transparence or translucent covering, and this covering 14 intercepts that optical configuration measurement machine with the ambient atmosphere of outer space by covering the optical whole configuration measurement machine.
[0029] Above-mentioned X-Y stage 2 is constituted by the X stage 21 and the Y stage 22. The above-mentioned X stage 21 is installed in X shaft orientations (shaft prolonged in the longitudinal direction of drawing 1) movable to the top face of the above-mentioned surface plate 10, and the above-mentioned Y stage 22 is installed in Y shaft orientations (shaft prolonged in the direction which intersects perpendicularly with the space of drawing 1 R> 1) movable to the X stage 21. These X stage 21 and the Y stage 22 are connected with the drive system of an illustration abbreviation, respectively, actuation control is carried out by the control signal from the above-mentioned controller 61 for gauge control, and each [these] drive system moves the above-mentioned thermal load equipment 5 to X shaft orientations and Y shaft orientations, respectively. In addition, what is necessary is just to combine various actuators, a moderation device, etc. as the above-mentioned drive system.
[0030] It is fixed to the above-mentioned perpendicular base member 12, and above-mentioned Z stage 3 holds the above-mentioned optical configuration system of measurement 4 possible [the migration (rise and fall) to Z shaft orientations (the vertical direction of drawing 1) which intersect perpendicularly to XY flat surface constituted by the above-mentioned X shaft orientations and Y shaft orientations].
[0031] What is necessary is for the guide member 31 which is fixed to the above-mentioned perpendicular base member 12, and carries out rise-and-fall guidance of the above-mentioned optical configuration system of measurement 4 as an example of this Z stage 3, the ball screw 32 which makes it go up and down that case 40 by stuffing the case 40 of that optical configuration system of measurement 4, and carrying out homotopic rotation, and the driving source 33 which it connects [driving source] with this ball screw 32, and carries out rotation actuation of the ball screw 32 in homotopic just to constitute. And actuation control is carried out by the control signal from the above-mentioned controller 61 for gauge control, and the driving source 33 moves the above-mentioned optical whole configuration system of measurement 4 to Z shaft orientations a minute amount every. In addition, a moderation device may be combined if needed that what is necessary is for the duty control just to perform a roll control, using a pulse motor as the above-mentioned driving source 33. the variation rate of Z shaft orientations in this case -- detection of an amount -- for example, the glass scale which attached the highly precise graduation -- the above-mentioned perpendicular base member -- fixing -- the graduation of this glass scale -- a light transmission type -- as a pulse signal -- detecting -- ****ing -- thereby -- the above -- a variation rate -- an amount can be detected in an about 0.1-micrometer unit. That is, the shape of below-mentioned toothing can be measured in the same unit.
[0032] The whole is arranged in the above-mentioned case 40, and the above-mentioned optical configuration system of measurement 4 is equipped with the microscope of an automatic focus method using the well-known knife-edge method. If the basic principle of the configuration measurement by the above-mentioned optical configuration system of measurement is explained based on drawing 2 , incidence will be carried out to the objective lens 44 as optical system through the beam expander 42 and a half mirror 43, it will converge with this objective lens 44, and the laser beam from the semiconductor laser diode 41 as

the light source will be irradiated by the minute spot of the below-mentioned work piece W. And if the reflected light from the work piece W reaches knife edge (shield) 45 through the above-mentioned objective lens 44 and a half mirror 43 and the above-mentioned objective lens 44 is in a focus location correctly to a work piece W (i.e., if spacing of an objective lens 44 and a work piece W is a focal distance), the above-mentioned reflected light will carry out incidence to the symmetry equally to each component of the photo detector 47 considered as vertical two piece housing through the half mirror 46.

[0033] Above-mentioned knife edge 45 is arranged so that only 1 side may be covered on both sides of an optical axis, and when the location of the above-mentioned objective lens 44 has shifted from the focus location to the work piece W, either becomes brighter, without the reflected light carrying out incidence to the symmetry to the photo detector 47 of the above-mentioned two piece housing. For this reason, by driving above-mentioned Z stage 3 and carrying out migration adjustment of the location of an objective lens 44 in the vertical direction, if the reflected light is made to carry out incidence to the symmetry to the above-mentioned photo detector 47, an objective lens 44 can be positioned in a focus location to a work piece W.

[0034] Therefore, the control procedure in the above-mentioned controller 61 for gauge control First, a work piece W is moved so that the optical axis of an objective lens 44 may agree at the point of measurement of a work piece W by moving X-Y stage 2 the specified quantity every to X shaft orientations and Y shaft orientations. By carrying out migration control of Z stage 3 in the location in response to the detecting signal from the above-mentioned photo detector 47, an objective lens 44 is made to agree in a focus location, and the amount of displacement of Z shaft orientations from the criteria location in that case is read. Next, a work piece W is moved by actuation of above-mentioned X-Y stage 2 till the next point of measurement, and Z axial displacement in the point of measurement is read like the above. If the above-mentioned amount of displacement is hereafter read in order about all the point of measurement set up beforehand, the shape of toothing of the top face of a work piece W will be acquired according to the difference of those amounts of displacement. By the above-mentioned controller 61, by processing the above-mentioned amount data of displacement, the shape of the profile of a work piece W and toothing on top is displayed on a display 63 as a bird's-eye view, or it has become that it seems that it is made to display as drawing of longitudinal section of a work piece W.

[0035] Next, the above-mentioned thermal load equipment 5 is explained based on drawing 3 and drawing 4 .

[0036] The closing motion aperture 51 as a transparence aperture which seals the above-mentioned thermal load equipment 5 possible [closing motion of top-face opening of the well-closed container 50 of dual structure, and this well-closed container 50], The tabular work-piece susceptor 52 arranged in the above-mentioned well-closed container 50, and the rise-and-fall means 53 as an attitude means which carries out modification accommodation of the vertical direction location of this work-piece susceptor 52, The ceramic heaters 54 and 54 of the pair of the shape of a tube as a heating element which is a heat source, It has the thermocouple 55 as an ambient temperature detection means to detect the ambient temperature in the above-mentioned well-closed container 50, and the thermocouple 56 (shown only in drawing 4) as a work-piece temperature detection means to detect work-piece temperature.

[0037] The above-mentioned well-closed container 50 is equipped with the inside container 72 which consists of bottom wall 72a which carried out opening of the top face to the outside container 71 which carries out opening of the top face, for example, consists of bottom wall 71a made from stainless steel, and surrounding side-attachment-wall 71b as a detail is shown in drawing 4 similarly, and was formed with the heat insulator, and surrounding side-attachment-wall 72b. Sizing of this inside container 72 is carried out so that it may be in the condition that that bottom wall 72a and surrounding side-attachment-wall 72b were mutually separated from bottom wall 71a of the outside container 71, and surrounding side-attachment-wall 71b, and it is supported by the condition that the above-mentioned bottom wall 72a floated in the upper part from bottom wall 71a of the outside container 71 through spacers 73 and 73. And the periphery enclosure of the upper limit opening edge of this inside container 72 is joined to the inner circumference edge of upper limit opening of the outside container 71, and the closure of the space between the outside container 71 and the inside container 72 is carried out.

[0038] The box-like container 74 is connected with the above-mentioned outside container 71 bottom, and a part for the principal part of the above-mentioned rise-and-fall means 53 is held in the interior of this box-like container 74. Base 74a of this box-like container 74 is made into a flat side, this base 74a is laid in the top face of above-mentioned X-Y stage 2, and maintenance of thermal load equipment 5 is performed.

[0039] On the other hand, the guide members 75 and 75 of the shape of a character of Reverse L are

attached in the both-sides location of upper limit opening of the outside container 71 at one, and maintaining the condition that the above-mentioned closing motion aperture 51 contacted the end face of upper limit opening of the above-mentioned inside container 72 by both these guides members 75 and 75, it slides on an one direction (drawing 3 and longitudinal direction of drawing 4), and opens and closes.

[0040] The above-mentioned closing motion aperture 51 is constituted by heat-resisting glass, and may have comes to pass an exposure and reflection of the laser beam from the above-mentioned optical configuration system of measurement 4 almost without a loss [****]. In addition, what is necessary is just to use the Pyrex glass (U.S. Corning trade name) which has the thermal resistance of 800 degrees C as heat-resisting glass.

[0041] The above-mentioned work-piece susceptor 52 is equipped with the housing 81 which consists of a surrounding frame and a surrounding middle crosspiece, and the support plate 82 inserted in the top face of this housing 81. It is referred to as back-face 82a with the flat top face of this support plate 82, and a work piece W is laid in the predetermined location of this back-face 82a. This support plate 82 has the rectangle of magnitude slightly smaller than the inner circumference enclosure of side-attachment-wall 72b of the above-mentioned inside container 72 by plane view, as shown also in drawing 5 , as shown in drawing 4 , it is positioned in the upper part location in that inside container 72 by side view, and the abbreviation partition of the building envelope of the above-mentioned inside container 72 is carried out up and down by this support plate 82. And on back-face 82a of the above-mentioned support plate 82, CSP made from a resin substrate and the CSP same as a dummy work piece Wd for the below-mentioned work-piece temperature detection as the above arrange as a work piece W of the measuring object, and it is laid (refer to drawing 5). As a material of such a support plate 82, even if it receives the greatest thermal load (for example, 300-degree C thermal load), the glass which has the thermal resistance of extent which can maintain the display flatness of back-face 82a, without generating curvature and deflection, and has the low specific heat rather than metals, such as steel, is used. What is necessary is just to specifically use the same Pyrex glass as the above.

[0042] The rise-and-fall actuation shafts 91 and 91 of a pair with which the predetermined range by the side of upper limit is thrust into the inferior surface of tongue of the housing 81 of the work-piece susceptor 52, and extends in Z shaft-orientations lower part, respectively as the above-mentioned rise-and-fall means 53 is shown also in drawing 6 in addition to drawing 4 , It has the middle transfer shaft 92 which is prolonged in X shaft orientations and transmits turning effort to both these rise-and-fall actuation shafts 91 and 91, and the actuation shaft 93 which is prolonged in Y shaft orientations and carries out rotation actuation of this middle transfer shaft 92 at the circumference of the y-axis. This actuation shaft 93 and the middle transfer shaft 92 are being engaged through the bevel gears 94 and 94 of the pair for changing and transmitting the turning effort of the circumference of the y-axis of the actuation shaft 93 to the turning effort of the circumference of a x axis to the middle transfer shaft 93. In addition, the above-mentioned middle transfer shaft 93 and each rise-and-fall actuation shaft 91 are being engaged through the worm 95 and worm gear 96 for changing and transmitting the turning effort of the circumference of the x axis of the middle transfer shaft 93 to each turning effort of the circumference of z1 shaft of each rise-and-fall actuation shaft 91, and the circumference of z biaxial. And by carrying out rotation actuation of the rise-and-fall handle 97 attached free [rotation] to the protrusion edge of the above-mentioned actuation shaft 93 at either, that turning effort is transmitted to the middle transfer shaft 92 by the bevel gears 94 and 94 of a top Norikazu pair from the actuation shaft 93, and where the turning effort of this middle transfer shaft 92 is slowed down by the above-mentioned worm gears 95 and 96, it is transmitted to each rise-and-fall actuation shaft 91. By both this rise-and-fall actuation shaft's 91 synchronizing, and holding homotopic, and rotating to the circumference of the z-axis, the housing 81 into which the upper limit part of each rise-and-fall actuation shaft 91 was thrust will carry out rise-and-fall actuation at Z shaft orientations, i.e., the upper and lower sides.

[0043] The ceramic heaters 54 and 54 of a top Norikazu pair have a core made from a magnesia refractory inside a ceramic tube, respectively, are made to generate heat by energizing to this core section, and emit radiant heat to the outer space of the above-mentioned ceramic tube. The ceramic heaters 54 and 54 of a top Norikazu pair are in the inside container 72, and they are arranged so that it may extend alternately in X shaft orientations to the space below the above-mentioned work-piece susceptor 52. Energization control is carried out by the controller 62 for temperature control, and each above-mentioned ceramic heater 54 heats the ambient atmosphere of the above-mentioned bottom space by the energization, and is spread by the heat in the ambient atmosphere of the space above the work-piece susceptor 52 by the convection current of air. And a work piece W and the dummy work piece Wd receive a thermal load indirectly according to the ambient atmosphere of this top space by which the temperature up was carried out.

[0044] The thermocouple 55 for ambient temperature detection is arranged in the bottom space of the above-mentioned inside container 72 with the above-mentioned ceramic heaters 54 and 54, and the ambient temperature detected by this thermocouple 55 is outputted to the above-mentioned controller 62. Moreover, the thing same as the above-mentioned dummy work piece Wd as the work piece W of the measuring object is adopted, and other thermocouples 56 are combined also with this dummy work piece Wd by means, such as adhesion. And the work-piece temperature detected by this thermocouple 56 is outputted to the above-mentioned controller 62.

[0045] The above-mentioned controller 62 is equipped with the 1st control section 64 (refer to drawing 1) to which the temperature up of the ambient temperature in the above-mentioned inside container 72 is carried out to target temperature, and the 2nd control section 65 to which the temperature up of the temperature of a work piece W is carried out to the above-mentioned target temperature. First, in the 1st control section 64, energization control to each ceramic heater 54 is performed so that the detection value of the ambient temperature outputted from the above-mentioned thermocouple 55 may reach desired value. For example, ON-OFF control may perform this energization control, and PI control or PID control may perform. If ambient temperature reaches desired value next, control which makes the temperature of a work piece W agree to the above-mentioned target temperature by the 2nd control section 65 will be performed. In this 2nd control section 65, energization control to each above-mentioned ceramic heater 54 is performed so that the detection value of the work-piece temperature outputted from the thermocouple 56 attached in the dummy work piece Wd may reach desired value. Control by such 2nd control section 65 is performed because work-piece temperature turns into temperature [a little] lower than ambient temperature, without being necessarily in agreement with ambient temperature. In addition, you may make it wait for the fixed passage of time so that work-piece temperature may get used to ambient temperature and may be stable in advance of control by the 2nd control section 65 of the above. And if work-piece temperature reaches target temperature, control by the controller 61 for configuration measurement will be performed next.

[0046] in this case -- for example, air is made to blow off from the slit of an illustration abbreviation towards the direction 1 side of X to the side else along the top face of the closing motion aperture 51 by the air curtain means forming 100, as shown in drawing 4 , this forms the air curtain which crosses the space between the above-mentioned closing motion aperture 51 and an objective lens 44, and the radiant heat which leaks to an objective lens 44 side through the closing motion aperture 51 is intercepted. That is, although the radiant heat out of the inside container 72 is somewhat reflected or absorbed by existence of the closing motion aperture 51 made from heat-resisting glass and heat damage prevention to an objective lens 44 is achieved even if there is no above-mentioned air curtain means forming 100, he is trying to attain twist certain-ization of the above-mentioned heat damage prevention by formation of the above-mentioned air curtain.

[0047] When configuration measurement in a thermal load environment is completed about one work piece W, or when configuration measurement in the thermal load environment of 1 cycle over one work piece W is completed, in order to perform the thermal load in the following cycle to a following work piece W or the same following work piece W, it is necessary to once cool the inside of a well-closed container 50 to ordinary temperature. Although the closing motion aperture 51 is wide opened for this cooling and you may make it wait for natural heat dissipation, to establish a forced-cooling means preferably and what is necessary is just made to perform forced cooling for shortening of the cycle time. What is necessary is attending each building envelope of the outside container 71 and the inside container 72, for example, opening a blast pipe for free passage to 1 side, making an exhaust pipe open for free passage to the side else as a forced-cooling means, respectively, sending compulsorily the clean air of cold blast or ordinary temperature with a blower fan etc., and making it just make it circulate.

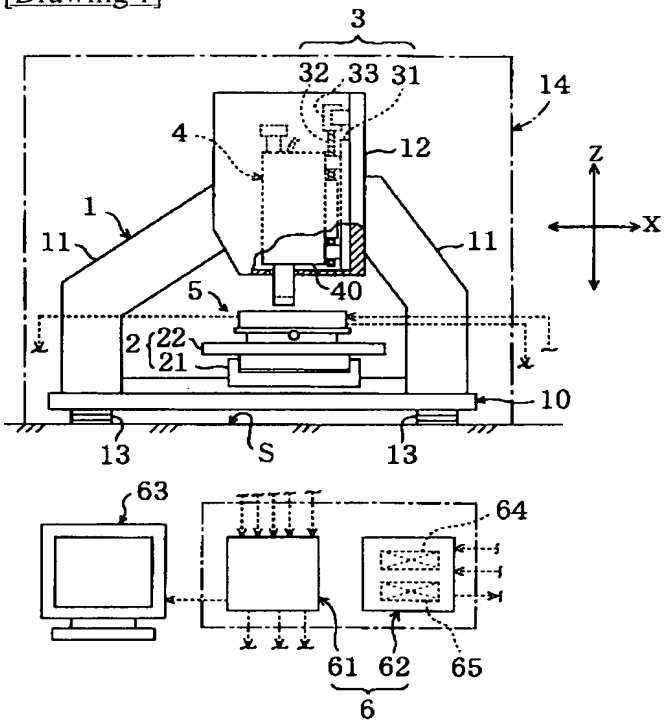
[Translation done.]

* NOTICES *

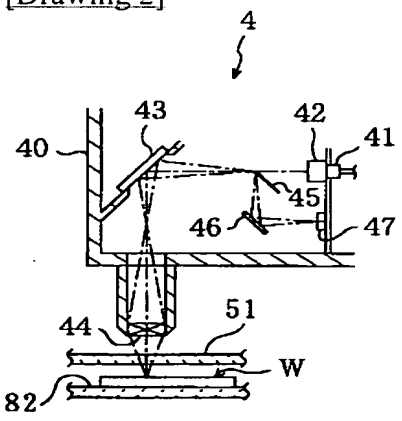
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

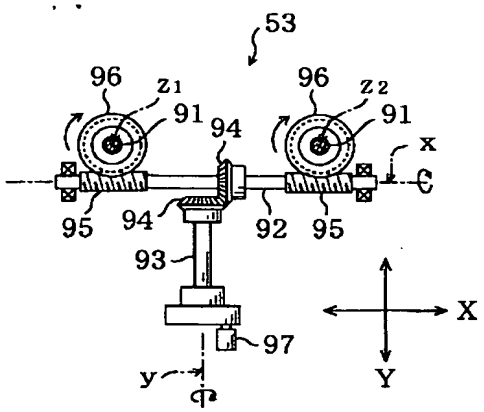
[Drawing 1]



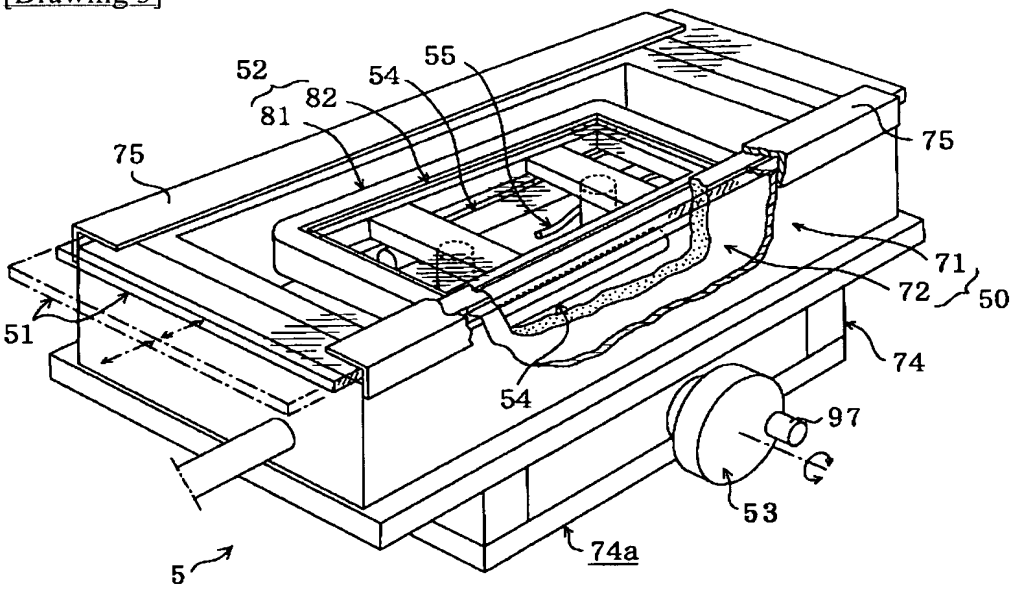
[Drawing 2]



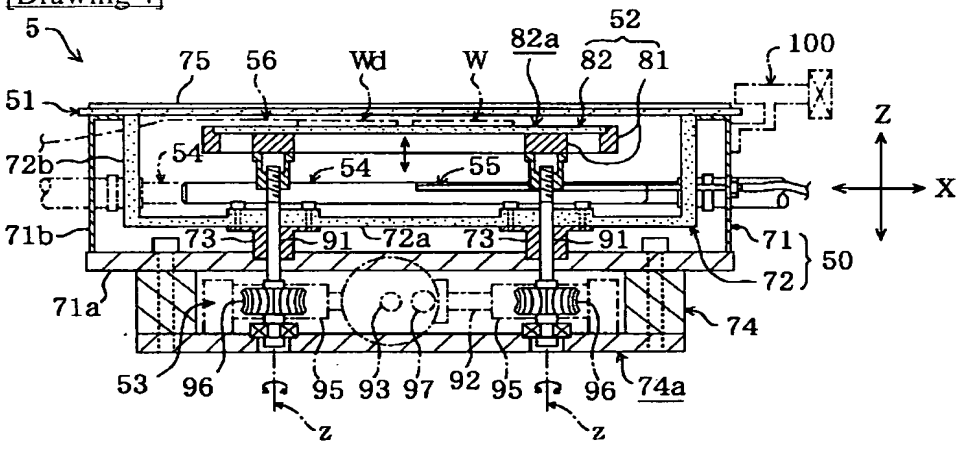
[Drawing 6]



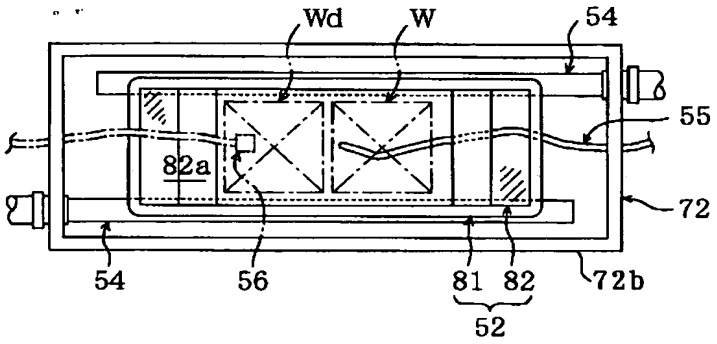
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]